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MECHANICAL-PROPERTY DATA
HM21A MAGNESIUM

Sheet (-T81)

Issued by

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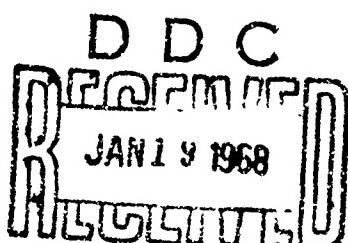
F33615-67-C-1292

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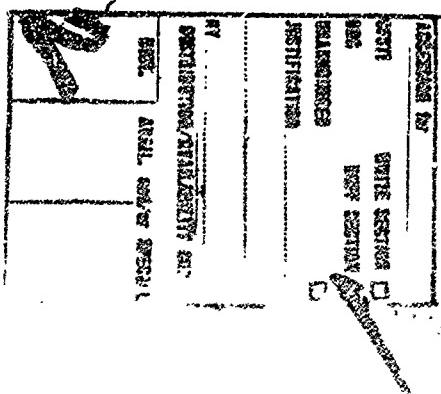
This data sheet was prepared by Battelle Memorial Institute under Contract F33615-67-C-1292. The contract was initiated under Project No. 7381, "Materials Application", Task No. 738106, "Design Information Development". The major objectives of this program are to evaluate newly developed structural materials of potential Air Force weapons-system interest and then to provide data-sheet-type presentations of mechanical data. The program was assigned to the Structural Materials Engineering Division at Battelle under the supervision of Mr. Walter S. Hyler. Project engineer was Mr. Omar Deel. The program was administered under the direction of the Air Force Materials Laboratory, Air Force Systems Command, Wright-Patterson Air Force Base, Ohio, by Mr. Marvin Knight, project engineer.

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HM21A

This alloy is one of a fairly recently developed series of heat-treatable magnesium alloys containing thorium and manganese as hardeners. It is intended primarily for service from 500 to about 800 F, where it is superior from a strength standpoint to the other magnesium alloys available in sheet and plate form.

This alloy can be welded and need not be stress relieved to prevent stress corrosion. It should be noted that HM21A in the -T81 temper is strain-rate sensitive.

The nominal composition of HM21A is as follows: 2.0 thorium, 0.80 manganese, other impurities to total not more than 0.30.

HM21A Data^(a)

Condition: T81
Thickness: 0.160-Inch Sheet

Properties	Temperature, F			
	RT	300	500	700
Tension				
F _{tu} (longitudinal), ksi	35.1	26.5	20.9	11.1
F _{tu} (transverse), ksi	36.5	26.1	21.0	12.9
F _{t_y} (longitudinal), ksi	28.8	24.2	19.5	10.2
F _{t_y} (transverse), ksi	27.5	22.8	18.9	11.6
e _t (longitudinal), percent in 2 in.	6.2	13.0	12.0	42.2
e _t (transverse), percent in 2 in.	15.8	21.7	13.3	34.2
E _t (longitudinal), 10 ⁶ psi	5.83	5.76	5.38	4.10
E _t (transverse), 10 ⁶ psi	6.05	5.84	5.26	4.58
Compression				
F _{c_y} (longitudinal), ksi	23.2	21.7	19.0	1.8
F _{c_y} (transverse), ksi	23.3	21.2	19.3	1.9
E _c (longitudinal), 10 ⁶ psi	6.43	6.12	5.97	1.91
E _c (transverse), 10 ⁶ psi	6.67	6.20	5.91	1.04
Shear^(b)				
F _{s_u} (longitudinal), ksi	27.2	U	U	U
F _{s_u} (transverse), ksi	27.5	U	U	U
Impact (V-notch Charpy)	U ^(c)	U	U	U
Fracture Toughness, K _{I_C} , ksi $\sqrt{\text{in.}}$	U ^(d)	U	U	U

Properties	Temperature, F			
	RT	300	500	730
<u>Axial Fatigue (transverse)(e)</u>				
Unnotched, R = 0.1				
10 ³ cycles, ksi	32.2	33.2	27.0	U
10 ⁵ cycles, ksi	27.2	23.7	23.0	U
10 ⁷ cycles, ksi	18.3	14.4	13.5	U
Notched (K _t = 3.0), R = 0.1				
10 ³ cycles, ksi	25.6	25.8	23.5	U
10 ⁵ cycles, ksi	22.5	11.2	11.2	U
10 ⁷ cycles, ksi	9.3	5.0	4.3	U
<u>Creep (transverse)</u>				
0.2% plastic deformation				
100 hr, ksi	NA	21.4	22.2	3.1
0.2% plastic deformation				
1000 hr, ksi	NA	20.2	11.0	3.8
<u>Stress Rupture (transverse)</u>				
Rupture 100 hr, ksi	NA	22.9	15.6	3.9
Rupture 1000 hr, ksi	NA	22.4	16.3	2.5
<u>Stress Corrosion</u>				
80% E _{ty} , 100 hr max		No cracks(f)	U	U
<u>Coefficient of Thermal Expansion(g)</u>				
12.2 x 10 ⁻⁶ in./in./F (68-212 F)				
13.8 x 10 ⁻⁶ in./in./F (68-392 F)				
<u>Density(g) 0.064 lb/in.³</u>				
(a) Data are average of triplicate tests conducted at Battelle under the subjects' contract. Creep stresses indicated. Fatigue, creep, and stress-rupture values are from data curves generated using a power number of 10±1.				
(b) Single-shear shear type specimen, full thickness.				
(c) U, unavailable; NA, not applicable.				
(d) Single-edge-notched (3 x 12 in.) tension specimen. No porosity detected. Test conditions not known were one', and L _c the secant modulus method in ASTM STP 416 and proved to be leveled X _{1/2} in. 23.				
(e) "R" represents the algebraic ratio of the minimum stress to the maximum stress in one cycle, R = Δσ / σ _{min,max} . "% " represents the Hauber-Peterman theoretical stress concentration factor.				
(f) Three-point bend test. Alternating immersion in 1/2M sodium chloride at 20°C, no cracks detected.				
(g) Values from References (1) and (2).				

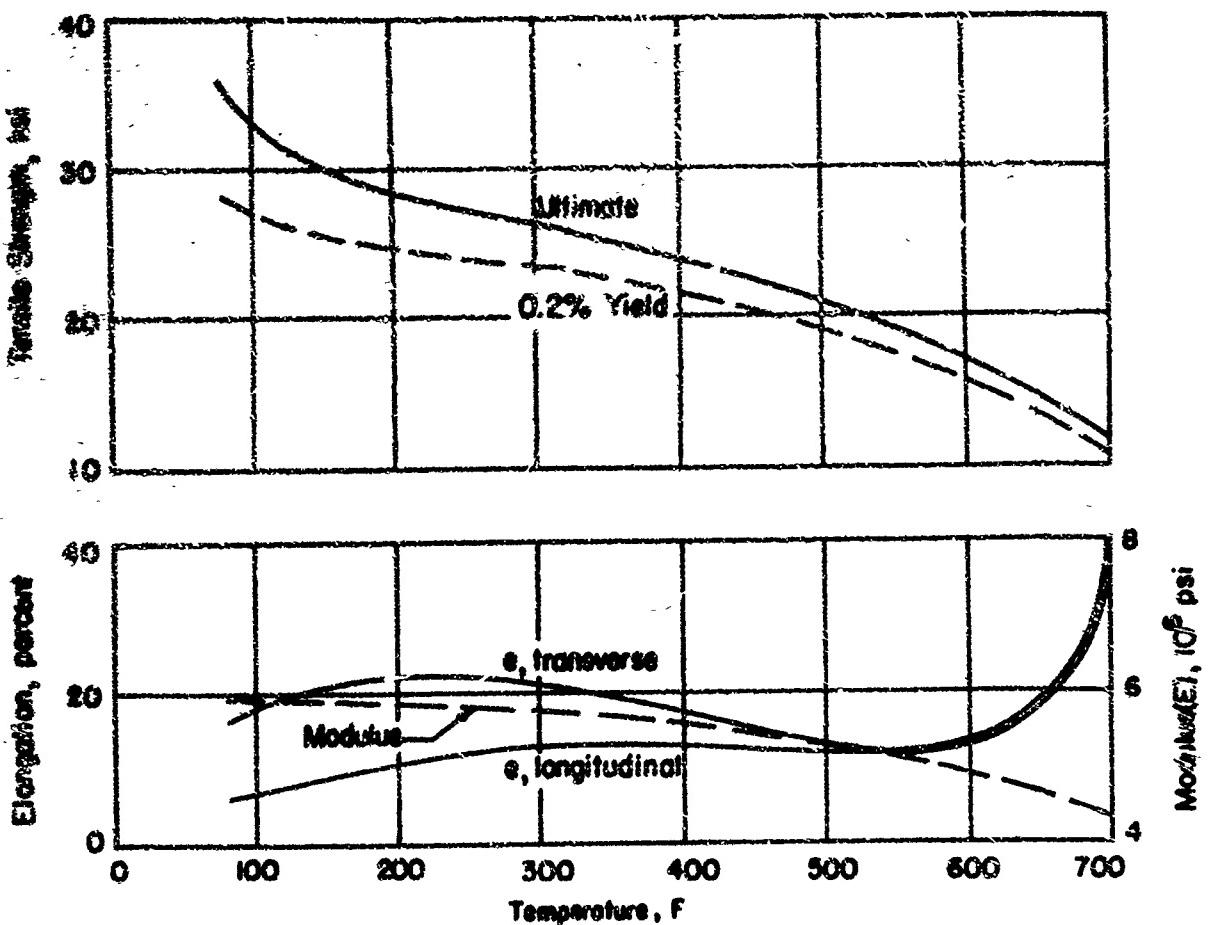


FIGURE 1. EFFECT OF TEMPERATURE ON THE TENSILE PROPERTIES OF HM21A-T81 MAGNESIUM SHEET

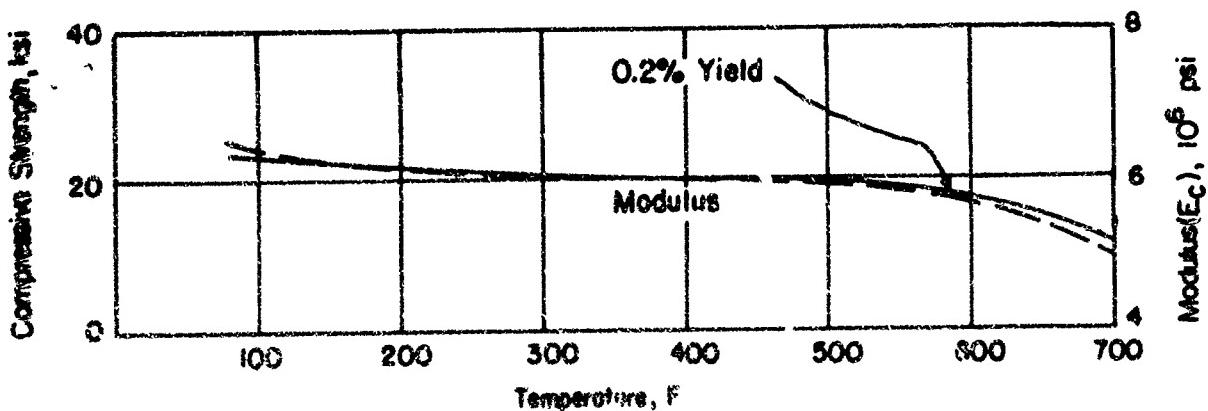


FIGURE 2. EFFECT OF TEMPERATURE ON THE COMPRESSIVE PROPERTIES OF HM21A-T81 MAGNESIUM SHEET

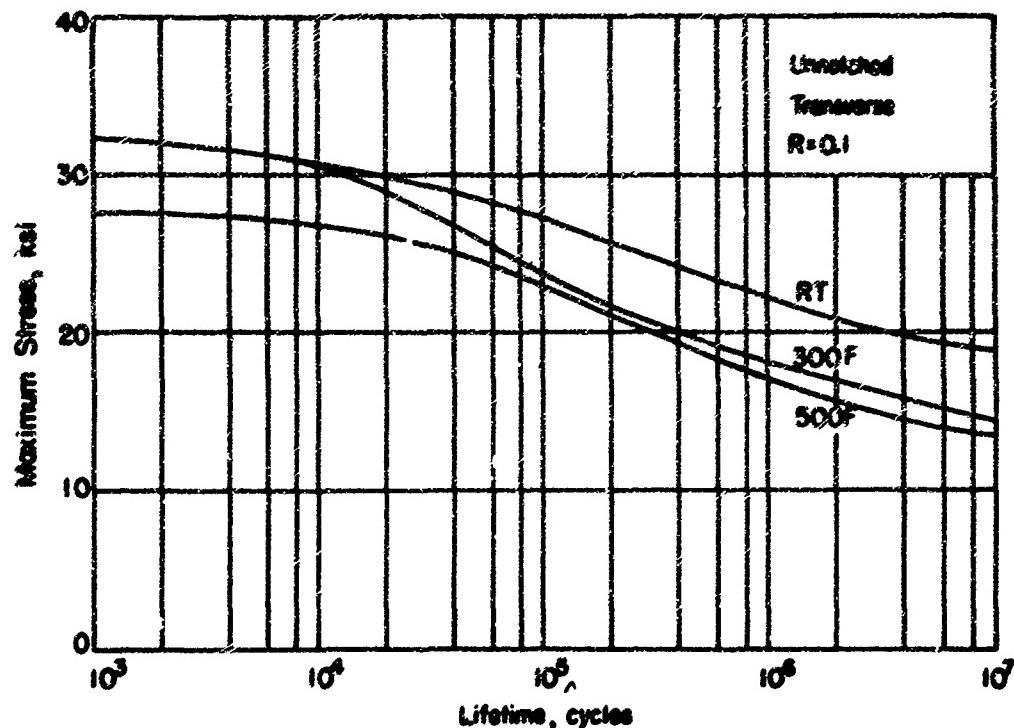


FIGURE 3. AXIAL-LOAD FATIGUE RESULTS FOR HM21A-T81 MAGNESIUM SHEET

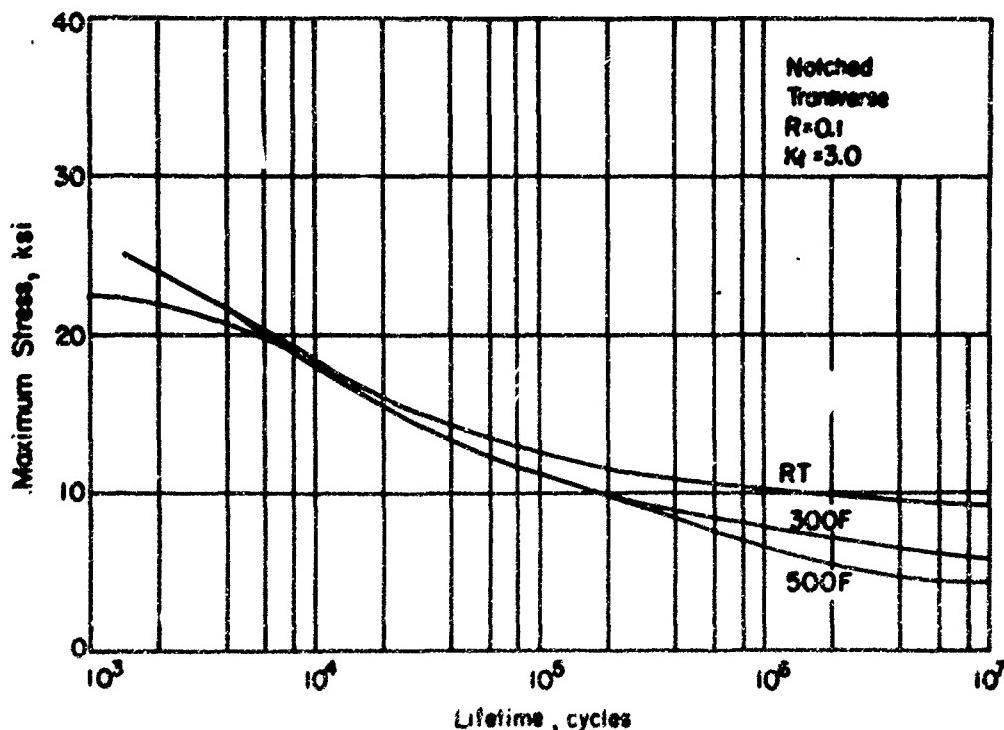


FIGURE 4. AXIAL-LOAD FATIGUE RESULTS FOR NOTCHED ($K_t = 3.0$) HM21A-T81 MAGNESIUM SHEET

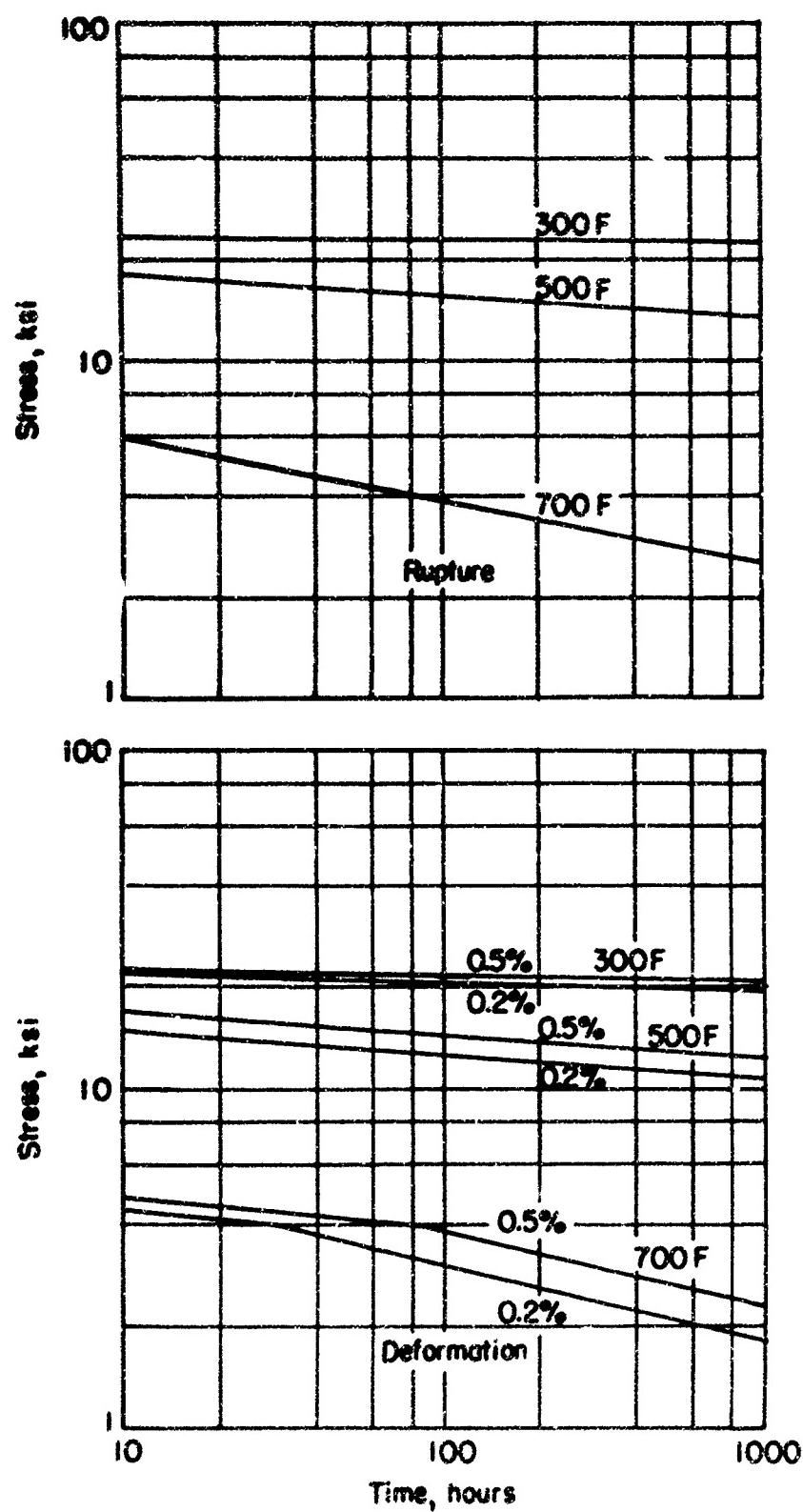


FIGURE 5. STRESS-RUPTURE AND PLASTIC DEFORMATION CURVES FOR HM21A-T81 MAGNESIUM SHEET AT THREE TEMPERATURES

REFERENCES

- (1) MIL-HDBK-5A, "Metallic Materials and Elements for Aerospace Vehicle Structures" (February 8, 1966), Change Notice 2.
- (2) "Aerospace Structural Metals Handbook", ASD-TDR 63-741, Vol. II, prepared by Syracuse University Research Institute.